INSTRUCTIONS

LOCOMOTIVE AIR SYSTEMS

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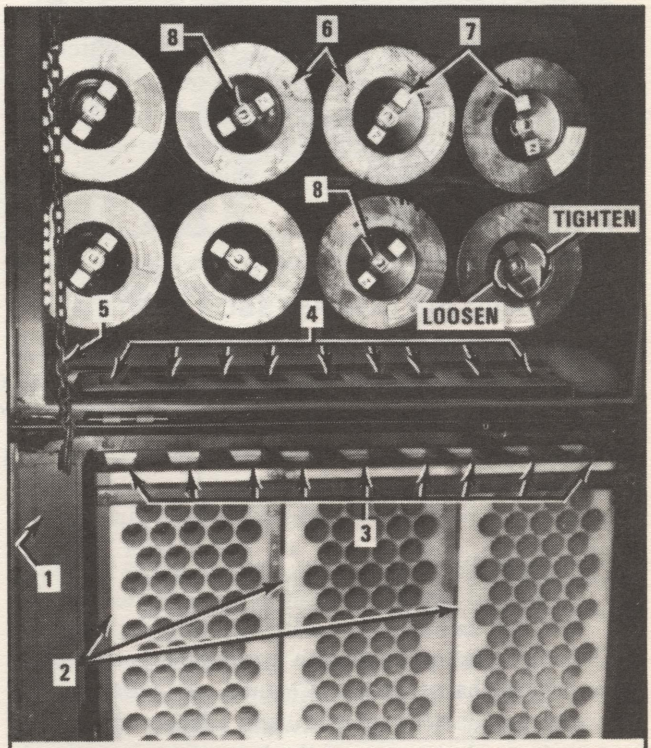


REF.	DESCRIPTION
1	FILTER-COMPARTMENT DOOR
2	PRIMARY AIR CLEANERS
3	DIRT DISCHARGE PORTS
4	BLEED AIR PORTS
5	DOOR-SUPPORT CHAIN (OPTIONAL)
6	AIR FILTER ELEMENT
7	ELEMENT-SECURING BOLT
8	STEEL-RUBBER GASKET

FIG. 1. TYPICAL ENGINE AIR FILTER COMPARTMENT.

FIG. 1, E-21235

DESCRIPTION OF SYSTEMS

The locomotive has several independent air systems, each performing a function in the overall performance of the locomotives. Fig. 14. These systems and their functions are:

COOLING-WATER RADIATOR AND COMPRESSOR-EXHAUSTER (OR COMPRESSOR) SYSTEM

The cooling-water system is monitored by two temperature switches, WT-1 and WT-2. When the water temperature rises to a given value, WT-1 switch is activated; its electrical contacts close and cause the radiator fan to operate at slow speed. Ambient air now enters the radiator cab through screened side sheets and is blown upward and out through the radiator-cab screened roof. This flow of air removes heat from the compressor-exhauster (or compressor) cylinder jackets, the compressor intercooler and the cooling-water radiator.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

GENERAL ELECTRIC

Should the water temperature continue to rise, WT-2 switch is activated; its contacts close and cause the radiator fan to operate at higher speed. As the water temperature is lowered, WT-2 switch opens and the radiator fan speed is reduced; when the water temperature is lowered further, WT-1 switch opens and the radiator fan speed is lowered to near zero rpm (some rotation results from residual magnetism in the eddy-current coupling.)

When the locomotive is equipped with a radiator shutter, WT-1 switch will control the flow of air, through an electromagnetic valve, to the radiator-shutter air cylinder. When WT-1 is activated, its contacts close and air is supplied to open the shutter; when de-activated, its contacts open, air is vented from the radiator-shutter air cylinder, and springs return the shutter to the closed position.

ENGINE AND AIR COMPRESSOR SYSTEM

Air is drawn into the compartment through V-screens attached to the outside of the compartment doors. See Fig. 1. This air is first filtered by GE plastic primary air cleaners mounted in the compartment doors. This air then passes through paper secondary filters into a clean-air plenum. Most of the air is passed to the engine, while a small portion goes to the air compressor. This is accomplished by a pipe (or pipes) extending from the air-compressor inlet to the clean-air plenum.

The engine is equipped with a turbocharger which is driven by exhaust gases. Cleaned air entering the turbocharger is compressed and delivered to the intercoolers, where some of the heat of compression is removed. Air then enters the two air intake manifolds, one on each side of the engine, from which it passes to the individual cylinders for combustion. The hot exhaust gases are conducted from the individual cylinders to the turbocharger and then out the stack to the atmosphere.

EQUIPMENT COOLING SYSTEM

Cooling air for the traction motors, main generator, auxiliary generators, and control compartment enters the blower compartment through V-screen sections in the sides of the engine cab. This air passes to the inlet openings of the equipment blower then downward thru a bank of plastic air cleaners. Some of this pressurized, filtered air is used by the generators, while the balance is delivered by the blower to the traction motors and the control compartment.

Air from the main generator is discharged out through engine compartment louvered doors (2) to the outside atmosphere. See Fig. 14.

DYNAMIC BRAKING GRID SYSTEM (IF USED)

When the locomotive is in dynamic braking, air is drawn in through V-screens on the right side of the engine cab by the braking-grid blower. This air is forced through the braking grids and out through louvers on the left side of the engine cab, Fig. 14.

MAINTENANCE

SCREENING

All screening, both V-type and plain, at the inlet openings to the various air systems must be kept clean and free of debris at all times.

PLASTIC PRIMARY AIR CLEANERS (See Fig. 2)

Periodic cleaning is not normally required since scouring by dust, rain and snow provides all the cleaning necessary. Should the cleaners get an oil residue on their working surfaces, remove the cleaner panels and clean in a cleaner suitable for polypropylene. See DATA section for approved cleaners. After cleaning, rinse in clear water and dry before re-installing in the locomotive.

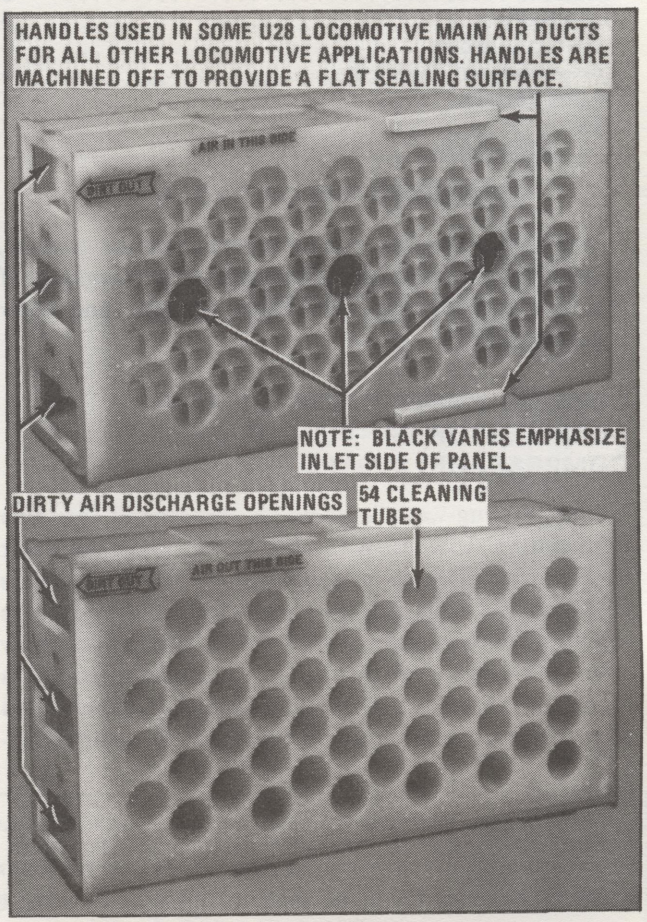

HANDLES USED IN SOME U28 LOCOMOTIVE MAIN AIR DUCTS FOR ALL OTHER LOCOMOTIVE APPLICATIONS. HANDLES ARE MACHINED OFF TO PROVIDE A FLAT SEALING SURFACE.
NOTE: BLACK VANES EMPHASIZE INLET SIDE OF PANEL
DIRTY AIR DISCHARGE OPENINGS
54 CLEANING TUBES

FIG. 2. PLASTIC PRIMARY AIR CLEANERS.

FIG. 2, E-18619A

FIG. 3, E-18620

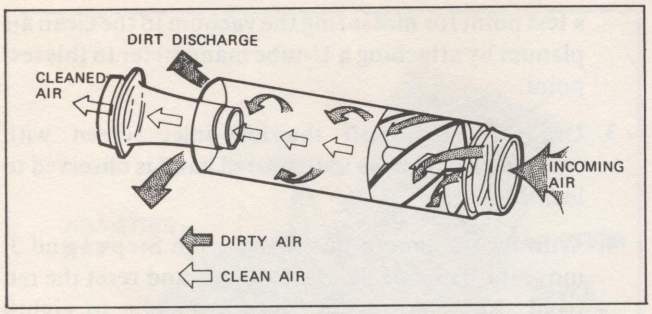


FIG. 3. AIR-CLEANER-TUBE AIR FLOW.

CAUTION: ***The air filter compartment doors are generally restrained by chains. In order to remove the cleaner panels from these doors, first it is necessary to open all doors below the filter compartment, then disconnect the chains and open the compartment doors, as shown in Fig. 1. Failure to follow this procedure will result in damage to the screening and the doors below the compartment.***

PAPER SECONDARY FILTERS (See Fig. 1)

Paper filter elements are arranged in two assemblies, each mounted on an outside vertical panel of the clean air plenum. Engine combustion air, after passing thru the V-screens and plastic primary cleaners, passes thru each paper filter element — from the outside to the center tube — and is collected in the clean air plenum.

No precise frequency for changing filter elements can be given; this will have to be determined and will depend on the environment in which the locomotive operates. The need for a filter element change will be indicated by the display of the red band in the service indicator. See Figs. 4 and 5.

FIG. 4, E-21236

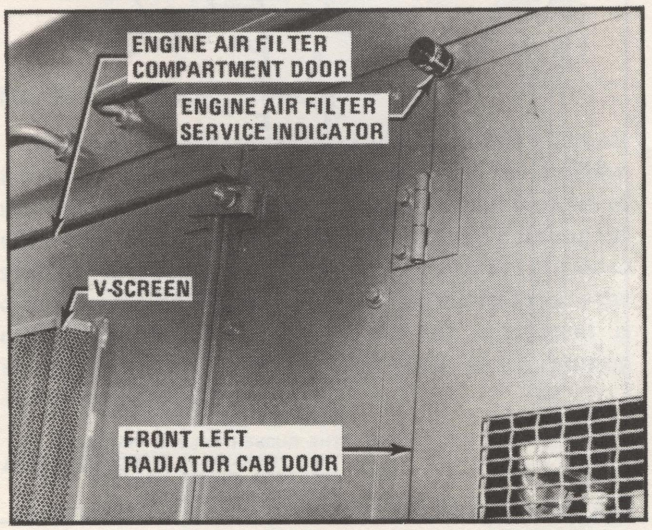


FIG. 4. LEFT SIDE OF LOCOMOTIVE SHOWING ENGINE AIR FILTER INDICATOR.

FIG. 5, E-21237

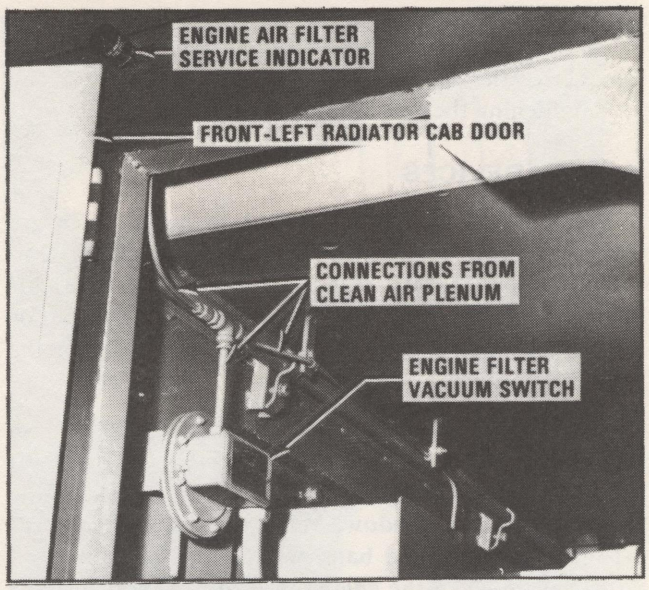

ENGINE AIR FILTER SERVICE INDICATOR
FRONT-LEFT RADIATOR CAB DOOR
CONNECTIONS FROM CLEAN AIR PLENUM
ENGINE FILTER VACUUM SWITCH

FIG. 5. LEFT SIDE OF LOCOMOTIVE SHOWING ENGINE AIR FILTER INDICATOR AND VACUUM SWITCH.

With the engine shut down, filter elements are renewed by performing the following operations on EACH side of the locomotive:

1. Loosen the two clamp nuts; rotate the two clamps to clear the door; and open the door to a horizontal position, as limited by the support chain.

   NOTE: ***If doors are not equipped with support chains, or if it is desired to open the doors completely (after unhooking the chains), it is first necessary to completely open the two doors below the air filter compartment door. See CAUTION in preceding section under Plastic Primary Air Cleaners.***

2. Loosen and remove all element-securing bolts. Discard the old steel-rubber gaskets and air filter elements.

3. Inspect the compartment and make certain there are no cracks or leaks, especially in the area of the vertical panel which forms part of the clean air plenum. Also check the door gasket, which must be able to seal out dirt and water.

4. Install a new gasket on the element-securing bolt with the steel face toward the handle of the bolt. Install the bolt thru both holes in a new filter element, then install the element in place and secure hand-tight with the element-securing bolt. Repeat this procedure for all elements.

   NOTE: ***A new steel-rubber gasket is included with each new filter element and should be found taped to the metal face of the element.***

5. Inspect all elements for proper positioning.
6. Close the compartment door and secure it by tightening the two clamps.

SAFETY DEVICES

Safety or protective devices are provided to insure against improper operation of the engine air system. These devices operate from the vacuum in the clean air plenum. Dirt accumulation on the secondary air filter or primary air cleaner gradually increases the vacuum in the clean air plenum.

One of these devices is the service indicator located on the outside of the locomotive cab. See Figs. 4 and 5. As the vacuum increases, the red band gradually rises in the service indicator window. When the vacuum reaches -12 in. water, the red band will lock in place and no longer drop when the engine is at idle. This will occur only with the diesel engine in eighth notch full-load.

After confirmation of this condition with the manometer, the filter elements should be changed. To reset the service indicator, push the reset button located on the bottom of the indicator.

Should the filter elements not be changed, the vacuum in the clean air plenum will increase at an accelerated rate. When it reaches -14 in. water, the second safety device, a vacuum pressure switch located in the radiator cab, energizes the EPFR relay and returns the engine to idle. A trainline alarm rings and the ENGINE AIR FILTER light illuminates on the engine control panel.

This circuit can be reset by momentarily depressing the PAPER FILTER RELAY RESET SWITCH button. If the shutdown was a true indication, the engine will again go to idle as soon as the engine is advanced to eighth notch full-load.

CAUTION: ***This circuit must not be jumpered out, because the rapid build-up of pressure drop across the secondary air filter will reduce the air to the diesel engine and result in catastrophic failure of the diesel engine.***

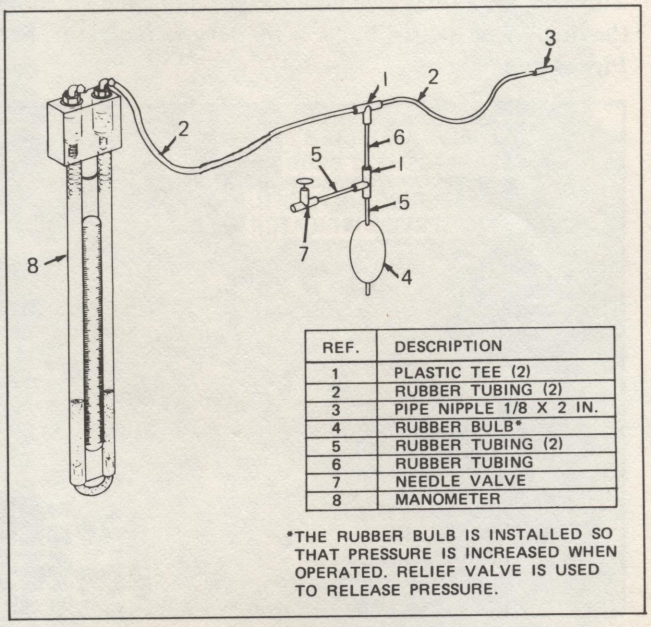
The operation of the service indicator can be checked by using the following procedure. With the diesel engine in eighth notch full load:

1. Close off one-half of the right inlet screen with cardboard or canvas.
2. Temporarily remove the service indicator and, in its place, install a 1/8 in. tee. In one of the tee openings install a 1/8 in. nipple, then re-install the service indicator on this nipple. Use the other tee opening as a test point for measuring the vacuum in the clean air plenum by attaching a U-tube manometer to this test point.
3. Gradually close off the left inlet screen with cardboard or canvas until the red band is observed to lock in place.
4. With the cardboard positioned as in Steps 1 and 3, move the Throttle handle to IDLE and reset the red band. Next, move the Throttle handle to eighth notch full-load. The pressure will depress slowly because of the slow turbo-response at near maximum rpm. Observe the vacuum when the red band locks in place.
5. The observed vacuum on the U-tube manometer should be minus 11.5 to 12.5 in. water.

The vacuum pressure switch can be checked by following the instructions for the service indicator. The engine should go to idle; the trainline alarm should ring; and the ENGINE AIR FILTER light should illuminate on the engine control panel when the U-tube manometer reaches minus 13.5 to 14.5 in. water.

The engine filter vacuum switch that operates when the vacuum in the clean air plenum reaches -14 in. of water may be tested using the equipment shown in Fig. 6, with the engine shut down, in the following manner:

1. Remove the vacuum-switch cover.
2. Remove one wire, and attach an ohmmeter to the electrical terminals.



REF.	DESCRIPTION
1	PLASTIC TEE (2)
2	RUBBER TUBING (2)
3	PIPE NIPPLE 1/8 X 2 IN.
4	RUBBER BULB*
5	RUBBER TUBING (2)
6	RUBBER TUBING
7	NEEDLE VALVE
8	MANOMETER

*THE RUBBER BULB IS INSTALLED SO THAT PRESSURE IS INCREASED WHEN OPERATED. RELIEF VALVE IS USED TO RELEASE PRESSURE.

FIG. 6, E-14955A

FIG. 6. ENGINE FILTER VACUUM SWITCH TEST EQUIPMENT.

FIG. 7, E-21259

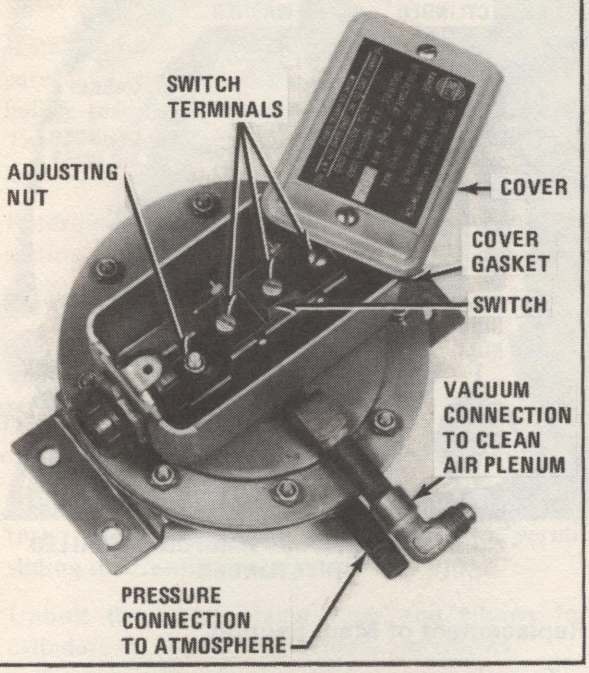


FIG. 7. ENGINE FILTER VACUUM SWITCH.

3. Connect the 1/8 in. pipe nipple (3) to the 1/8 in. pressure connection located on the outside of the vacuum switch. See Fig. 7.

4. Use the bulb (4) to increase the pressure on the switch until the vacuum switch is seen to close by observing the ohmmeter. If the vacuum switch does not operate by 13.5 to 14.5 in. of water, correct the adjustment by turning the adjusting nut clockwise to increase pressure, and counterclockwise to decrease pressure. If the vacuum switch cannot be adjusted to the designated pressure, repair or replace the vacuum switch.

MAIN AIR DUCT

Seals and flexible connections, used at points where air from the main air duct is channeled to the traction motors, must be kept tight. Inadequate maintenance of these seals and connections will result in dirt entering the system and contaminating the motors. Loose connections and bad seals also may permit leakage to the extent that the air delivered to the equipment is inadequate for cooling. This can result in overheating and damage.

AIR ELBOWS

Connecting air elbows between the turbocharger and the intercoolers are constructed with adjustable flanges at the intercoolers, see Fig. 8. This allows for slight

FIG. 8, E-9966

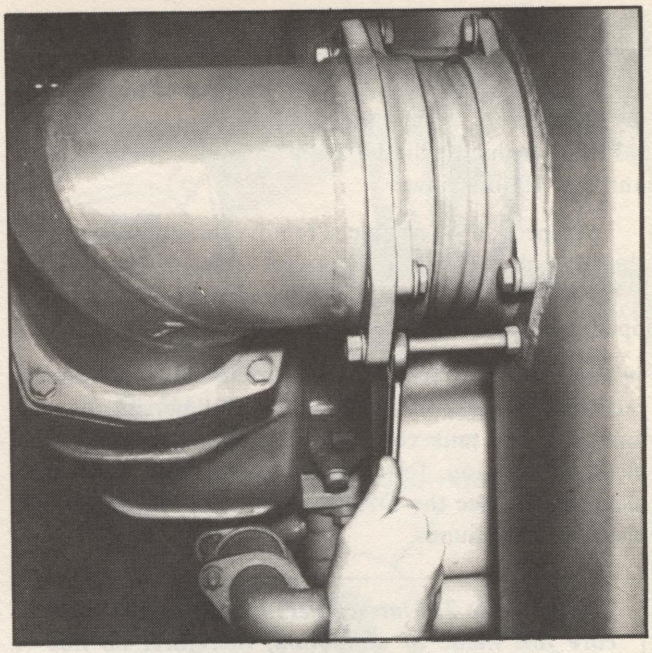


FIG. 8. ASSEMBLING ADJUSTABLE ELBOW.

variations in alignment between flange connections. When assembling the elbows, the hex nuts on the studs at the intercooler should be loosened several turns to allow for adjustment. Make sure the sealing O-rings are in place. Install and tighten bolts in all the flanges. At this time, the hex nuts on each side of the adjustable flange may be drawn up evenly, while care is taken not to distort the elbow in the process.

INTERCOOLERS

The engine is equipped with two intercoolers which modify the temperature of the air supplied to the cylinders. Each intercooler has a steel fabricated case enclosing a tube and fin type radiator core. The water headers, at top and bottom, are removable. Air heated by compression in the turbocharger then passes horizontally through the core. Heat is removed and carried away by engine cooling water which flows through the tubes in the core in three passes; up, down, and up again. At idle or at light loads in cold weather, the air may be warmed by heat flow from the water.

The radiator core is permanently mounted in the intercooler case, while the top and bottom headers may be removed to permit cleaning and repair of the tubes.

NOTE: ***Intercooler parts such as the case with core and the end headers are not interchangeable, since some of the machining is completed after the parts are fitted together. Should an intercooler require extensive repair, it should be returned to the factory for reconditioning and proper fitting of new parts.***

Each intercooler should be inspected periodically for dirt build-up in the air passages of the core. If, through poor filter maintenance, dirt is permitted to accumulate in the intercoolers, it will restrict air flow to the engine, resulting in high cylinder temperature, smoky exhaust and loss of horsepower.

To inspect the intercoolers, remove the elbows between the turbocharger and intercoolers (refer to Fig. 8), and observe the condition of the core fins through the inlet opening. A very light coating of oily dust is normal.

The preferred method of cleaning the cooler is by removing the headers and completely immersing the case and core in a tank containing an appropriate agitated cleaning solution, followed by a thorough rinse with clean water. See the DATA section for recommended cleaning compounds.

CAUTION: ***The intercoolers are constructed with core fins made of aluminum; therefore, do not subject cores to cleaning agents which are harmful to aluminum.***

Before the top and bottom headers are applied, the cooler should be air-tested for leaks in the tubes. Construct and apply gasketed blanking plates over the air openings, with one plate adapted for an air-hose connection. With the cooler case completely immersed in clean water, apply regulated air pressure of 30 psi maximum to the cooler. Inspect the case and tubes for leaks as indicated by air bubbles. For later repair, mark the location of leaks, using a wax crayon.

Leaks in the tubes may be eliminated by plugging both ends of such tubes with solder or plugs made of phenolic resin. Renew the intercooler if more than ten percent of the tubes in any one of the three sections, determined by the water flow path, require blocking. Should a leak develop in the intercooler case, it may be repaired by welding with mild steel welding rod.

AIR INTAKE MANIFOLDS

Air intake manifold clamp ring bolts must be kept tight to avoid air leaks, see Fig. 9. When assembling sections of the manifolds, such as after a cylinder changeout, care should be taken that the sealing O-rings are in place and the interconnecting tubes are properly centered, as evidenced by the beads being visible at each side, as shown in Fig. 10.

EXHAUST MANIFOLD — SINGLE-PIPE

The single-pipe exhaust manifold is used on all locomotives equipped with a 12 or 16-cylinder engine.

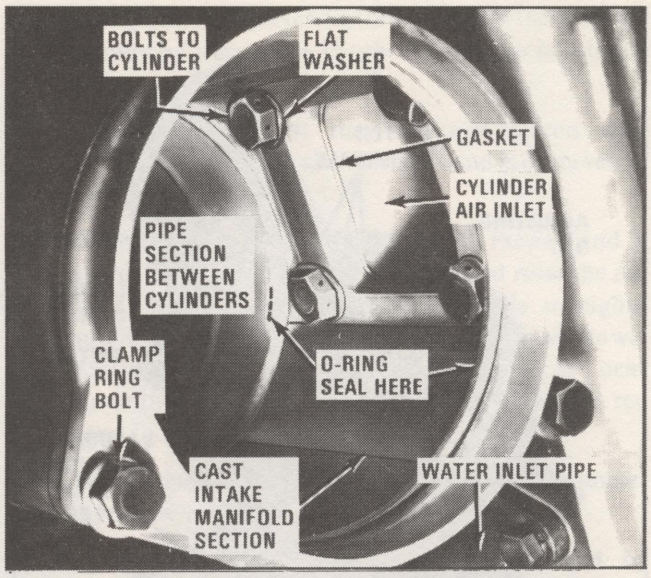


FIG. 9. SECTION OF AIR MANIFOLD INSTALLED ON CYLINDER.

FIG. 9, E-9112C

Replacement of Main Section

To replace a manifold main pipe section, perform the following steps:

NOTE: ***Any main pipe section may be replaced without removing the water header. Carefully clean elbow joint parts and inspect for nicks which will not seal. Seal rings are reusable.***

1. Unbolt the elbow clamp rings on the elbows attached to the section to be removed, and on the left and right elbow of section just ahead of this one.
2. Remove the cylinder mounting bolts on the two elbows attached to the section to be removed. Also remove the elbow mounting bolts from the cylinder just ahead of the section to be removed. Remove elbows.
3. Remove the main clamp rings from both ends of the section to be removed.

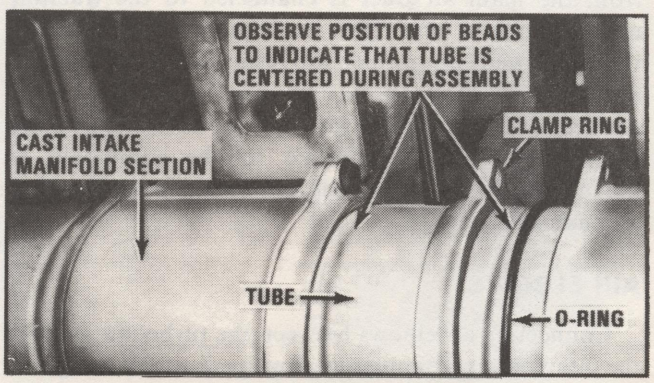

OBSERVE POSITION OF BEADS TO INDICATE THAT TUBE IS CENTERED DURING ASSEMBLY
CLAMP RING
CAST INTAKE MANIFOLD SECTION
TUBE
O-RING

FIG. 10. AIR INTAKE MANIFOLD.

FIG. 10, E-9971A

4. Carefully lift out the section, rotating to clear the water discharge header.
5. Install the new section in the reverse order, being careful to align the section to the mounted elbows before torquing the main and elbow clamp rings. Torque the main pipe clamping bolts to 70-75 lb.-ft. and the elbow clamping bolts to 18-20 lb.-ft.
6. Retorque all clamping ring bolts one month after section replacement.

FIG. 11, E-23573

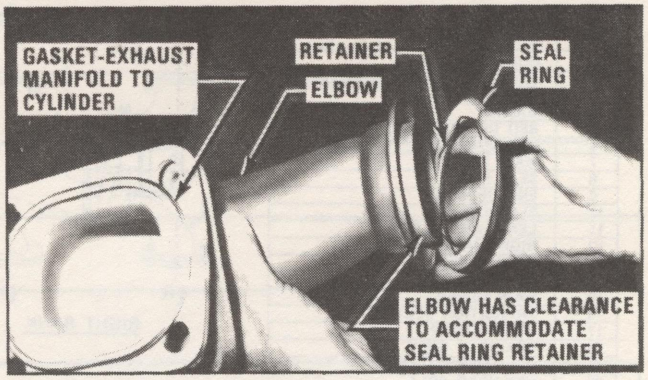


FIG. 11. SEAL RING RETAINER CORRECTLY APPLIED.

Replacement of Transition Section

To replace a transition section, proceed as follows:

1. Remove the top six socket-head bolts holding the turbo inlet casing to the turbo housing (to permit sliding the transition section straight up).
2. Unbolt the elbow clamp rings and elbows for cylinders 1L and 1R, and remove the elbows.
3. Remove the clamp ring at the forward end of the first main pipe section.
4. Remove the clamp-ring bolts which secure the transition section to the turbocharger.
5. Lift this section up and out toward the left side of the engine.
6. Reverse these procedures to install a new section. Torque the manifold clamping bolts to 70-75 lb.-ft. and the mainfold to turbo inlet clamp bolts to 70-75 lb.-ft. Torque the cylinder exhaust port to manifold elbow bolts to 100-110 lb.-ft.
7. Retorque all bolts one month after section replacement.

FIG. 12, E-23572

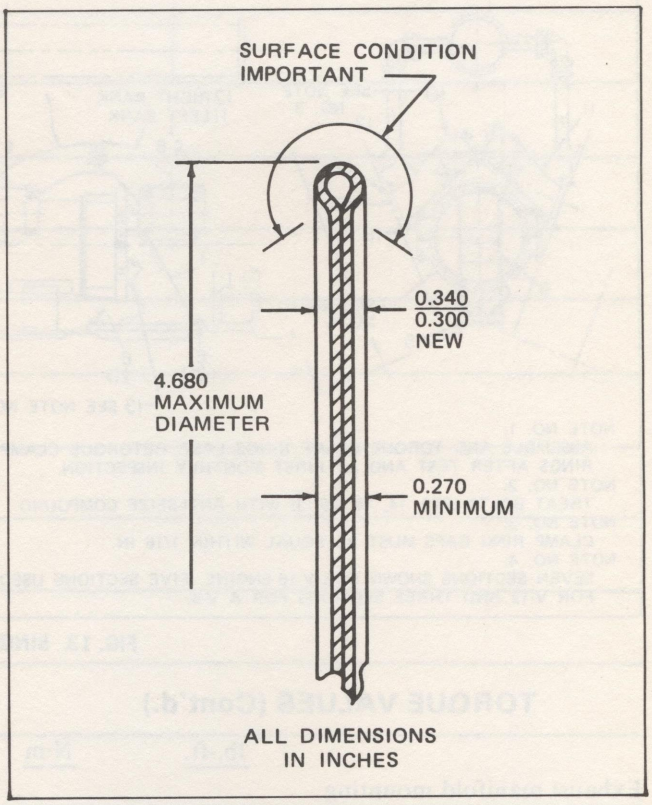


FIG. 12. SEAL RING DIMENSIONAL LIMITS.

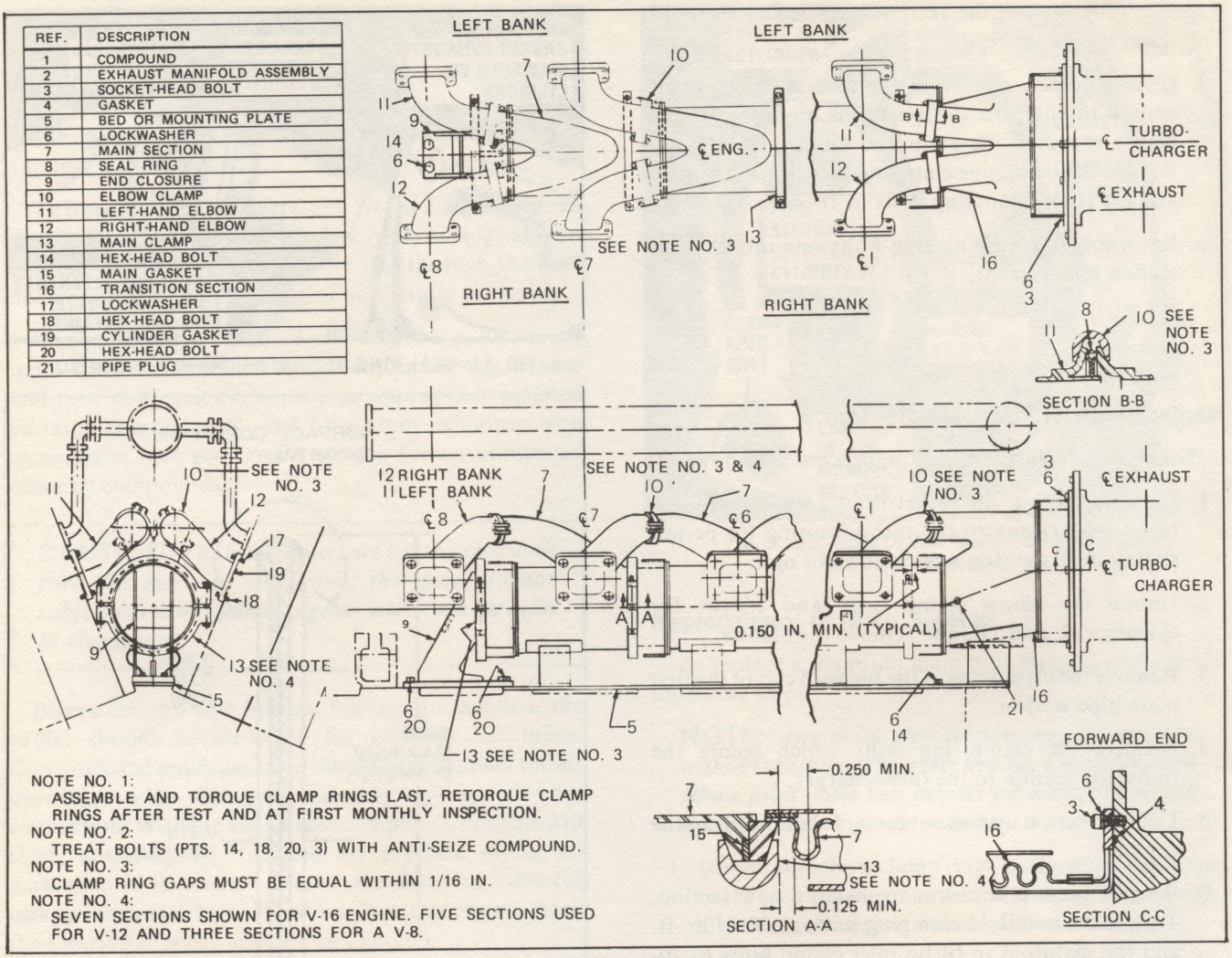
Seal Rings

The seal rings between manifold sections and cylinder elbows may be reused if they are within the dimensional limits as shown in Fig. 12 and if the sealing surface is not nicked or dented.

When installing a seal ring, make sure that the spring wire retainer is on the side toward the cylinder connection. The manifold elbow has clearance to accommodate this retainer. Should the ring be put on with the spring retainer toward the main section, clearance will be lacking and a leak will probably result. See Fig. 11 for correct application of seal ring retainer.

TORQUE VALUES

	lb.-ft.	N·m
Exhaust stack clamping bolts (1/2 in.) (all)	55-60	75-81
Exhaust manifold to turbo-charger inlet clamp bolts (single pipe)	70-75	95-102
Exhaust manifold elbow clamp bolts (single pipe)	18-20	24-27
Exhaust manifold main pipe clamping bolts (single pipe)	70-75	95-102



REF.	DESCRIPTION
1	COMPOUND
2	EXHAUST MANIFOLD ASSEMBLY
3	SOCKET-HEAD BOLT
4	GASKET
5	BED OR MOUNTING PLATE
6	LOCKWASHER
7	MAIN SECTION
8	SEAL RING
9	END CLOSURE
10	ELBOW CLAMP
11	LEFT-HAND ELBOW
12	RIGHT-HAND ELBOW
13	MAIN CLAMP
14	HEX-HEAD BOLT
15	MAIN GASKET
16	TRANSITION SECTION
17	LOCKWASHER
18	HEX-HEAD BOLT
19	CYLINDER GASKET
20	HEX-HEAD BOLT
21	PIPE PLUG

NOTE NO. 1:
ASSEMBLE AND TORQUE CLAMP RINGS LAST. RETORQUE CLAMP RINGS AFTER TEST AND AT FIRST MONTHLY INSPECTION.
NOTE NO. 2:
TREAT BOLTS (PTS. 14, 18, 20, 3) WITH ANTI-SEIZE COMPOUND.
NOTE NO. 3:
CLAMP RING GAPS MUST BE EQUAL WITHIN 1/16 IN.
NOTE NO. 4:
SEVEN SECTIONS SHOWN FOR V-16 ENGINE. FIVE SECTIONS USED FOR V-12 AND THREE SECTIONS FOR A V-8.

FIG. 13, E-13439C

FIG. 13. SINGLE-PIPE MANIFOLD.

TORQUE VALUES (Cont'd.)

	lb.-ft.	N·m
Exhaust manifold mounting bolts (1/2 in.) (single pipe)	50-55	68-75
Exhaust manifold flange to cylinder bolts (all)	100-110	136-149
Air intake manifold to cylinder bolts	55-60	75-81
Air intake clamp to intake manifold bolts	35-40	47-54

DATA

Settings

Engine filter service indicator ..... −11.5 to −12.5 in. (292 to 318 mm) water

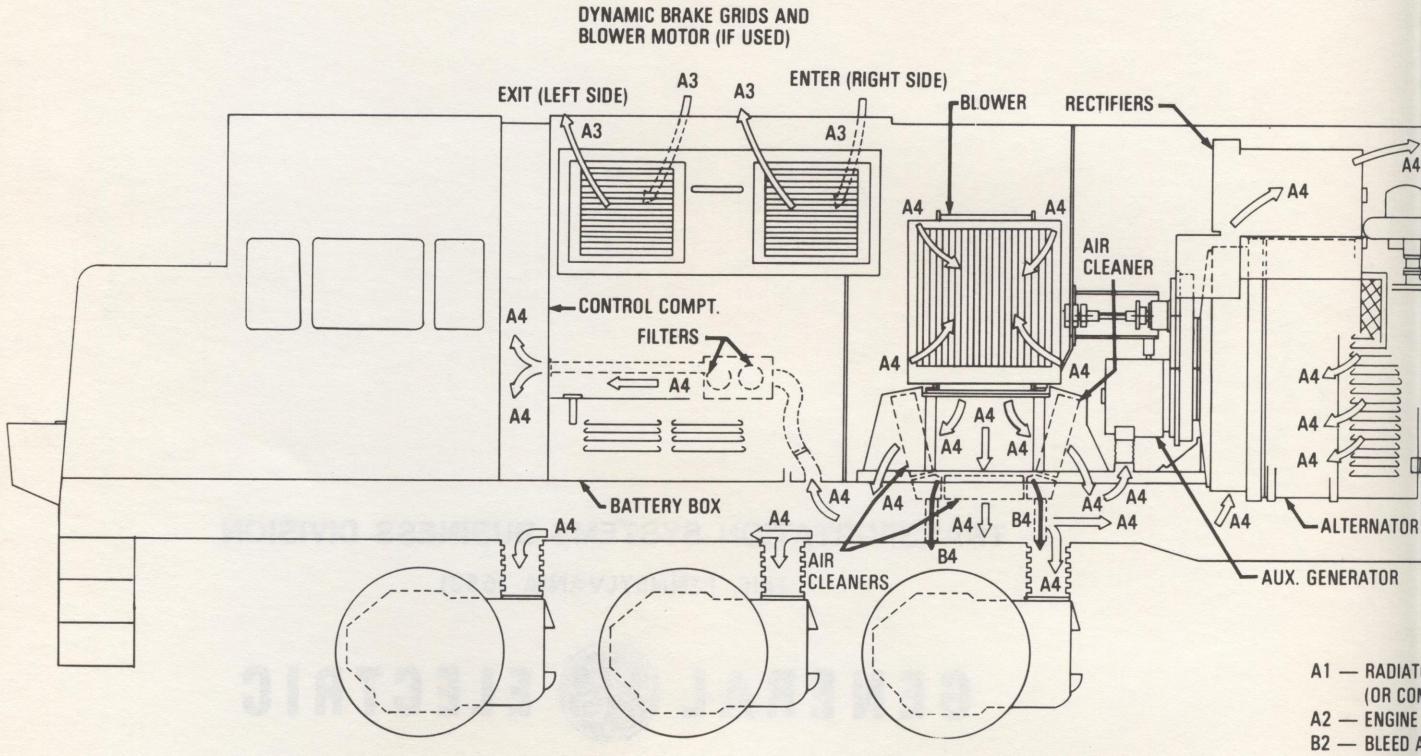
Engine filter vacuum switch..... −13.5 to −14.5 in. (343 to 368 mm) water

Cleaning Compounds

Non-caustic type recommended for polypropylene plastic, stainless steel, galvanized steel, and paint.

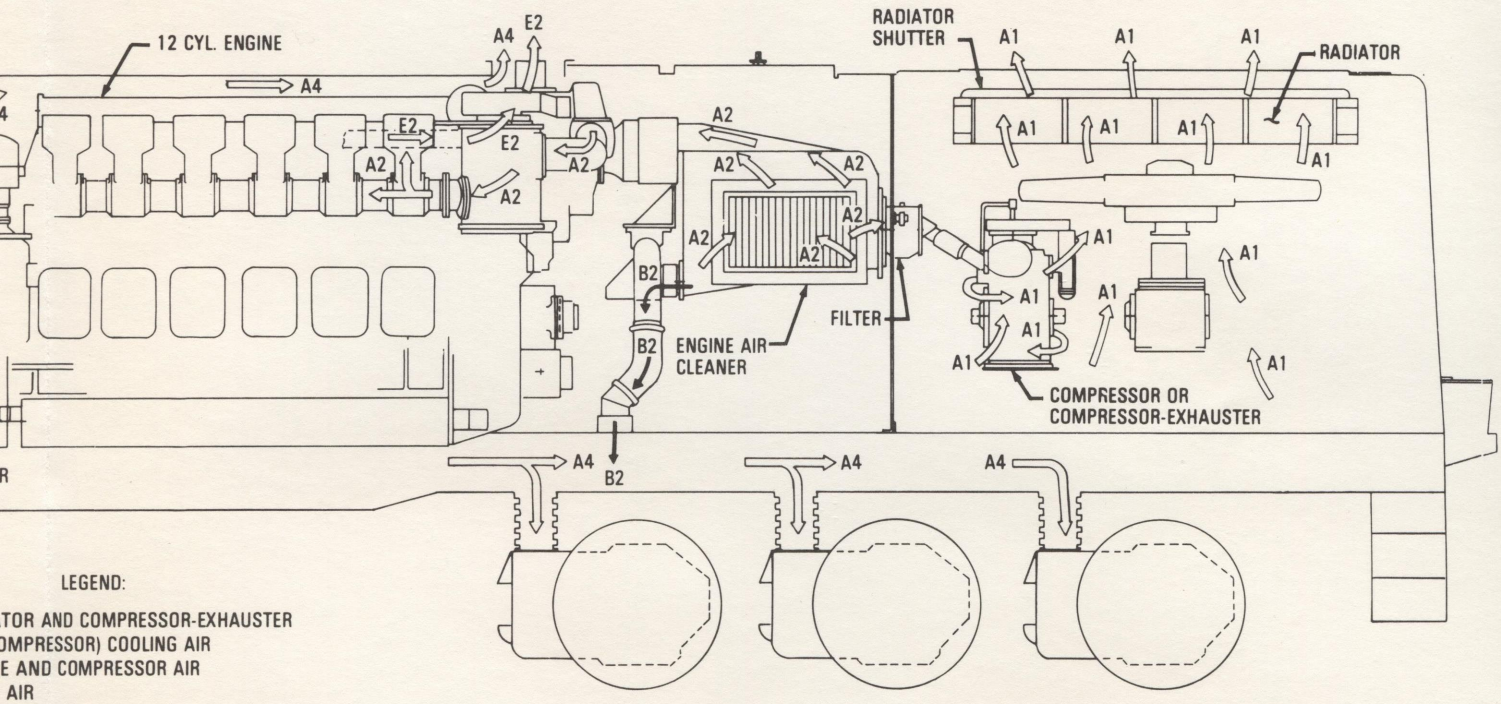
Name of Product	Name of Manufacturer
Oakite Composition No. 111	Oakite Products, Inc.
Pennsalt Delchem Super CR Pennsalt Cleaner 44	Pennsalt Chemicals Corp.
Magnusol	Magnus Chemical Co., Inc.
Turco Mulsirex	Turco Products, Inc.

NOTE: ***Use the above cleaners according to directions supplied by the cleaner manufacturer. Equivalent cleaners made by other manufacturers may also be used.***



A1 — RADIAT
(OR CO
A2 — ENGINE
B2 — BLEED A
E2 — ENGINE
A3 — DYNAM
A4 — EQUIPM
B4 — BLEED A

FIG. 14, E-27552



LEGEND:

TOR AND COMPRESSOR-EXHAUSTER
OMPRESSOR) COOLING AIR
E AND COMPRESSOR AIR
AIR
E EXHAUST
MIC-BRAKE COOLING AIR
MENT COOLING AIR
AIR

FIG. 14. LOCOMOTIVE AIR SYSTEMS.